EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 62256382
PUBLICATION DATE : 09-11-87

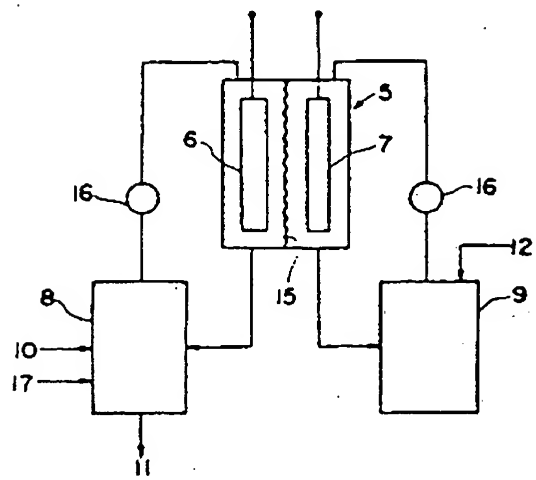
APPLICATION DATE : 30-04-86
APPLICATION NUMBER : 61097987

APPLICANT : TSUNODA HIDEO;

INVENTOR : TSUNODA HIDEO;

INT.CL. : H01M 8/18

TITLE : REDOX CELL



ABSTRACT : PURPOSE: To reproduce a positive electrolyte without use of electric power and to produce a microorganism or a metabolite of the mocroorganism by using iron solution as a positive electrolyte in which a microorganism is used for reproduction.

CONSTITUTION: Reduction with a gas containing reducing gas 12 such as hydrogen and city gas, photochemical reduction with optical catalyst, and bioreaction reduction is performed in a tank 9. Reproduction of a positive electrolyte is performed by a positive electrolyte reproducing bioractor 8 with a microorganism. The air 16 is intro duced into the bioractor 8, and reaction of the positive electrolyte is $Fe^{2+} \rightarrow Fe^{3+}$.
The microorganism 10 is propagated by using energy produced in oxidation reaction and carbon dioxide in the air as a carbon source, and separated with a suitable separating device. The positive electrolyte reproduced is returned to a flow-type electrolytic bath 5 through a pump 16, and the propagated microorganism or a metabolite is taken out from the reactor.

M050503

JP Patent Publication (Kokai) No. 62-256382 A (1987)

SPECIFICATION

1. Title of the Invention

REDOX CELL

2. Sole Claim

A redox cell comprising an iron solution as a positive electrolyte, in which the positive electrolyte is reproduced by a microorganism.

3. Detailed Description of the Invention

[Technical Field]

The present invention relates to a redox cell, and more particularly relates to a redox cell utilizing a microorganism.

[Prior Art]

An electric cell, in which a redox solution kept in a tank is supplied to a flow-through type electrolytic bath such that the cell can be charged and discharged, is referred to as a redox cell. Fig. 2 explains the principle of such a redox cell.

The redox solution contains ions having variable valence numbers, such as iron or chromium ions, as active materials. The solution is composed of a positive electrolyte and a negative electrolyte, which are supplied to a positive electrode chamber 6 and a negative electrode chamber 7, respectively, of a flow-through type electrolytic bath 5, said chambers being separated by a diaphragm 15. The anode and cathode electrolytes are selected depending on

the solubility of the active materials that constitute the respective electrolytes, standard electrode potentials, or the like.

The following formulae describe oxidation-reduction reactions in the aforementioned electrolytic bath when Fe and Cr ions are used in the anode and cathode electrolytes, respectively.

Positive Electrode:	$Fe^{3+} + e \Leftrightarrow Fe^{2+}$	(1)
Negative Electrode:	$Cr^{2+} \Leftrightarrow Cr^{3+} + e$	(2)
Overall Reaction:	$Fe^{3+} + Cr^{2+} \Leftrightarrow Fe^{2+} + Cr^{3+}$	(3)

That is, iron and chromium ions do not directly react with each other; however, their electrons are transferred via an external circuit. Thus, the reaction energy is converted into electric energy. In each reaction, when the reaction proceeds from the left to the right, discharge occurs. If discharge performance declines, the reaction proceeds from the right to the left, so that the electrolytes are reproduced. The reproduction may be carried out electrically; that is, by charging. Alternatively, it is clear that the positive electrolyte may be oxidized using air, a gaseous fuel, or the like while the negative electrolyte is reduced. Therefore, a redox cell can be classified as an electrically chargeable regeneration-type fuel cell.

[Problem to Be Solved by the Invention]

It is an object of the present invention to provide a redox cell, in which a positive electrolyte is reproduced without using electric power while a microorganism and/or a metabolite thereof can be simultaneously produced.

[Means for Solving Problem]

The present invention relates to a redox cell comprising an iron solution as a positive electrolyte, in which a microorganism is used for the

of the active materials, from divalent ferrous iron (Fe^{+2}) to trivalent ferric iron (Fe^{+3}), include the following known bacteria:

Thiobacillus ferrooxidans;

Leptspirillum ferrooxidance;

Leptospirillum like bacteria; and

iron-oxidizing strains belonging to the genus *Sulfolobus*.

All these bacteria are classified as acidophilic iron-oxidizing microorganisms. These microorganisms may be used alone or as a combination of twp or more bacteria. Also, variants of such microorganisms (bacteria), which are excellent in terms of oxidizing ability and substance production ability, can be used. Such variants may not only be found in nature, but may also be produced by an artificial technique, such as ultraviolet radiation, gene introduction, or gene recombination. In addition, these bacteria may be used together with other microorganisms.

The reproducing reactions by microorganisms may be carried out batch-wise or continuously. Microorganisms used may be dispersed in a system or immobilized on a carrier. When microorganisms are immobilized on a carrier, they can easily be recycled or collected, particularly in a continuous system. Examples of carriers that can be used include activated carbon, inorganic oxides, and various forms of organics. In the above reproduction reaction, when trace nutrients such as copper sulfates can be added in addition to known nutrients for microorganisms, propagation of microorganisms or metabolite production can be promoted, resulting in higher reaction rates.

Fig. 1 shows an example of the redox cell of the present invention. In

Fig. 1, the elements in the negative electrolytic chamber are basically the same as those of Fig. 2 described above. However, there is provided a tank 9 for reproduction, instead of the negative electrolyte tank 14 in Fig. 2. Tank 9 is used to perform reduction using a gas comprising a reducing gas 12, such as hydrogen or a city gas, photochemical reduction using a photocatalyst, or reduction by bioreaction. The positive electrolyte is reproduced in a bioreactor 8 for positive electrolyte reproduction using a microorganism according to the present invention. Air 16 is introduced into the bioreactor, resulting in the reaction $Fe^{2+} \rightarrow Fe^{3+}$ in the positive electrolyte. The microorganism 10 added to the reactor propagates using energy generated in the oxidation reaction and a carbon source, such as carbonic acid gas in the air. Then, the microorganism is separated using a known appropriate separator. The thus reproduced positive electrolyte is transferred back to the flow-through type electrolytic bath 5 via a pump 16, and the propagated microorganism (and/or metabolites produced) 11 is removed from the reactor. The reaction in the electrolytic bath upon discharging is as described above.

[Example]

A batch-wise reproduction test using a microorganism in a positive electrolyte was conducted under the following conditions.

Positive electrolyte composition:

Fe^{+3} ...0 mol

Fe^{+2} ...0.2 mol (ferrous sulfate)

pH ... 1.5 (sulfuric acid)

Bacterium used:

T. ferroxidans

(initial concentration in the electrolyte of approximately 1×10^7 cells/ml).

Nutrients (K_2HPO_4: 0.1g/l; $(NH_4)_2SO_4$: 0.1g/l) were added to the above

bacterium-containing medium. The medium was agitated while being subjected to air blowing at 25°C under ordinary pressure. The resulting solution was analyzed after 15 hours (without lag time). The following results were obtained.

Fe^{+3} ...0.2 mol

Fe^{+2} ...0 mol

Bacterial concentration in the solution: 5 to 6 × 10^{11} cells/ml

In the above test, the theoretical quantity of electricity applied to the reproduced solution was 0.013 Faradays per liter of solution per hour, and the number of the bacterium produced was 3 to 4 × 10^{10} cells per liter of solution per hour.

[Effects of the Invention]

As described above in detail, in addition to the production of electric power, the redox cell of the present invention realizes the production of bacterial cells and any constituents thereof, such as nucleic acids, enzymes, proteins, coenzymes, lipids, and saccharides, or metabolites.

4. Brief Description of Drawings

Fig. 1 shows an example of the present invention. Fig. 2 is an explanatory view of a conventional redox cell.

1. Power Plant
2. Transformation Facility
3. Load
4. Inverter
5. Flow-Through Type Electrolytic Bath
6. Positive Electrode
7. Negative Electrode

8. Bioreactor

9. Tank

10. Microorganism

11. Propagated Microorganism

12. Reducing Gas

13. Positive Electrolyte Tank

14. Negative Electrolyte Tank

15. Diaphragm

16. Pump

17. Air